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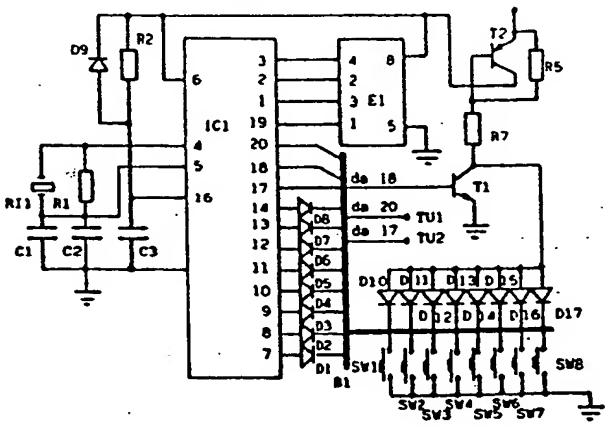
(54) Devices for the remote transmission of controls in security.

(57) Devices for the remote transmission of controls in security constituted by a remote control device comprising a microprocessor equipped with EPROM and programmed in such a way to be suitable to code the output messages according to a fixed base code and a dynamic code, determined for any message performing a predetermined algorithm on the dinamic code employed in the previous transmitted message, and by a receiver connected to the means to control, comprising a microprocessor equipped with an EPROM and programmed in such a way to be suitable to check the code of the received messages on the ground of the same fixed base code of the remote control device and of the dynamic code, which it determines automatically performing the same algorithm of the remote control device on the stored dynamic code of the previous received message, and to transmit a control signal of the means to control after the positive comparison of the two codes of the input message with the base code and the new dynamic code, calculated by itself, taken toghether, being the base codes and part of the instructions for performing the algorithm, as the other instructions are comprised in the program, storable upon assembling of the devices in the EPROMs while the dynamic codes are stored and erased progressively during the various operations of the devices.

FIG.2



EP 0 372 285 A1

Devices for the remote transmission of controls in security.

This industrial invention refers to devices for the remote transmission of controls in security.

There exist till now many types of said devices, among which the most sophisticated are those which foresee the transmission also by radio of coded messages, so as an unauthorized person, which is in possesion of a remote control device which is acting with the same frequency, can not control said means as he does not know the code employed for decoding the transmitted message.

This difficulty can be overcome if the third unauthorized person has a device suitable for intercepting the control encoded messages during their transmission, for storing them and then for retransmitting them.

Aim of this invention is that of realizing a device for the remote transmission of controls in security also against the interception of encoded messages during their transmission, and of getting other advantages which will be evident in the following description.

The devices for the remote transmission of controls in security according to this industrial invention, are constituted by a remote control device comprehending at least an encoder module, a transmitting module of the encoded messages, a source of power and a control key, and by a receiver connected to the means to control, comprehending at least a module for receiving the encoded messages and a module of decoding, suitable to emit a control signal of said device after having checked the code of the received message, comprehending:

- the encoding module of the remote control device: a microprocessor (MPC) and at least a EPROM (EPROC), being the microprocessor MPC such and equipped with such a program to be suitable to perform the following functions:
- when the remote control device is acted the first time:
- reading in the special register of the EPROMC and storing in its internal memory (RAM) the code, expressed with a binary number, stored upon assembling of the remote control device, and that will be called for the sake of brevity in the description and in the claims "base code".
- reading in the special registers of the EPROMC and storing in its RAM the instructions expressed with binary numbers, stored in said registers upon assembling of the remote control device, relating to the succession of performing and to the coefficients of the operations foreseen by the program of MPC, which form the algorithm, that the MPC has to perform on the binary number of the base code for reaching a new code, which will be called in the description and in the claims "dynamic code",
- performing said algorithm on the base code and finding then the new dynamic code,
- erasing the base code in the EPROMC and storing in its place the new dynamic code,
- transmitting to the transmissiom module the message encoded according to the new dynamic code, so that said module provides for the transmission,
- for all times the remote control device is acted after the fist time:
- performing the same functions foreseen for the first time operating not more on the base code but on the last dynamic code memorized in the EPROMC,
- and the decoding module of the device connected to the means to control at least a microprocessor (MPD) and a EPROM (EPROMD), being the MPD such and programmed in such a way to be suitable to perform the following functions when receives an input encoded message:
- for the first input message
- holding it in its internal memory (RAM),
- reading in the EPROMD the base code, the same as the base code of the encoding module of the remote control device and holding it in its RAM, being the base code, stored in the EPROMD, upon assembling, the same as that of the EPROMC,
- reading in the EPROMD and storing in its RAM the instructions relating to the algorithm, the same as those of the encoder, which the MPD has to perform on the base code already stored in its RAM, having been stored said instructions in the EPROMD upon assembling of the relating module,
- performing said algorithm and determining so the new dynamic code and storing it in its RAM,
- comparing the code of the imput message with the dynamic code by itself determined with the performance of the algorithm on the base code,
- and in case of correspondence:
- emitting control signal to said means,
- and in case of non-correspondence:
- emitting no control signal,
- for all messages received after the first one:
- performing all operations foreseen for the first message, operating not more on the base code but on the last dynamic code stored in the EPROMD.

In a preferred solution similar to the previous one the remote control device transmits messages encoded not only on the ground of the base code but on the ground of the base code and the dynamic code taken together, and therefore the MPC is equipped with such a program to be suitable to perform the same functions foreseen in the first solution only that the base code stored in the EPROMC is never erased and upon every acting of

the remote control device the MPC reads in the EPROMC and stores in its RAM either the base code and the last stored dynamic code performs then the algorithm the first time on the base code and the following times only on the dynamic code and encodes the trasmitted messages on the ground of the double code constituted by the base code and the new dynamic code;
and the MPD is equipped of such a program to be suitable to perform the following functions:
- storing in its RAM the input encoded message,
- performing the algorithm on the dynamic code read in the EPROMD and determining so the new dynamic code,
- comparing the double code of the input message with the base code plus the the calculated dynamic code,
- in case of correspondence of both the two codes:
- emitting a control signal of said means,
- in case of correspondence of no one of the two codes:
- emitting no control signal,
- in case of correspondence of the base code but not of the dynamic code:
- to emit no control signal,
- and erasing the dynamic code stored in the EPROMD and storing in its place the dynamic code of the input message, in such a way that the following encoded message emitted by the remote control device will have a dynamic code calculated on the ground of of that stored in its EPROMC and that is equal to that of the previous transmitted message, received and stored in the EPROMD of MPD, that then in the comparison performed by the MPD will result equal to that stored in the EPROMD.

In an improvement of the previous solutions the MPD is equipped with such a program to be suitable to perform before storing the new dynamic codes in the EPROMD the following functions:
- checking if the last register employed for storing the previous dynamic code is already working,
- in positive case storing the new dynamic code,
- and in negative case checking if a new register works,
- then in positive case storing in this register the new dynamic code,
- and in negative case checking a new register and repeating the function until a working register is found, and then storing in this the new dynamic code.

In a further preferred solution the remote control device comprehends two or more control keys and is suitable to control two or more means and/or one or more functions of one or more of said means, corresponding to acting of a different key the control of a different means and/or of a different function, being the MPC of the remote control device equipped with such a program to be suitable to encode every output message either on the ground of the base code and of the dynamic code, and on the ground of the code of the channel corresponding to the key or to the keys acted contemporaneously, being every means equipped with a receiver comprehending a MPD programmed in such a way to be suitable to perform all the functions foreseen in the previous solutions and to emit the control signals from the ouput terminal or terminals corresponding to the channel code of the input messages, being therefore the remote control device suitable to control the means and the functions of said means according to the pre-arrangment of the connections of said ones to the output pins of the relating MPD.

In an improvement of the previous solution the remote control device comprehends a member suitable to act two or more keys contemporaneously.

For better explaining the invention according to this description it will be described an embodiment, only as an example, referring to the enclosed drawings, in which:

- figure 1 is a block diagram,
- figures 2, 3 are electronic diagrams.

The devices illustrated in the example refer to the remote control device of an antitheft apparatus IAF of two motor-cars, and particularly of the functions of arming and disarming, of the antirobbery function and of the panic function of said apparatus, and of the devices of opening and closing of the gates of a house and of a factory. Said devices are constituted by a remote control device I, comprehending an encoder module Ia, a radio transmitter module Ib, a micropile MB and a key board SW of control of eight switches SW1,SW2,SW3,SW4,SW5,SW6,SW7,SW8; and by four devices installed every one on board of each car and joined to each one of the two opening and closing members of the two gates, comprehending each of said devices an equal radio receiver II, constituted by a receiving module IIa and a decoding module IIb, suitable to send control signals respectively to the central functioning module III of the antitheft apparatus IAF of the two cars and of the opening and closing member of the gates. Only the encoder module Ia of the remote control device I and the decoding module IIb of the receivers I are described into details as all other modules are well known to the state of the art.

The encoder module Ia of the remote control device I is constituted essentially by the microprocessor, embodied by the integrated circuit IC1 (COP 822C Single Chip microCMOS Microcontroller of the National Semiconductor Corporation) and by a EEPROM E1 (NM 9308/COP494 256-Bit Serial Electric Erasable Programmable Memory of

the National Semiconductor Corporation). Pin 6 of IC1 is connected to the positive supply, while pin 15 is connected to ground. Pins 4 and 5 of the oscillating system of IC1 are connected to the ceramic resonetor RI1 of 1 MHz in parallel with the resistor R1 (1 Mo) and to the ground through condensers C1 and C2 (100 pF).

The reset pin 16 is connected through C3 (100 pF) to ground and through the parallel of diode D9 (1N4004) and R2 (100 Ko) to the positive, pins 7,8,9,10,11,12,13,14 are connected through diodes (1N4004) D1,D2,D3,D4,D5,D6,D7,D8 and the bus B1 to the eight control keys of IC1, while pins 3 and 1 are connected respectively to pins 4 and 3 of EEPROM E1 respectively for reading and storing in E1. Pins 2 and 19 ofIC1 are connected to pins 2 and 1 of E1 respectively for the clock pulses and for the selection of EEPROM, in this case not used because it is foreseen to employ only an EEPROM.

At last pins 17 and 20 are conncted to TU1 and TU2, which are the output terminals of the carrier and modulation signals. Pin 18 is connected to the base of transistor T1 (NPN BC182), pilot of transistor T2 (PNP BC182); T1 is equipped with load resistors R3 (1 Mo) of the base, and its collector is connected through R7 (27 Ko) to the base of T2 and through R5 (100 Ko) directly to the positive, the base of T2 is connected then through R7 and the diodes D10,D11,D12,D13,D14,D15,D16,D17 to the eight switches SW of the control keys, the opposite terminals of which are connected permanently to ground. The collector of T2 is connected permanently to positive supply while its collector is connected to the positive supply line of the encoder module and that is of IC1 and E1.

EEPROM E1 is equipped with three registers of eight bits for storing the base code, a reglster of 8 bits for storing the order of the operations foreseen by the program, according to which IC1 is masked, for the algorithm, that IC1 has to perform at beginning starting from the base code and successively from the dynamic codes for determining the following dynamic code, which are fixed in the example in succession an addition, a subtraction, a multiplication and the performance of the complement, while an other register of 8 bits is used for storing the coefficients of the single operations in succession and that is the addendum which has to be added to the base code, the number which has to be subtracted from the previous sum, the factor by which the result of the previous operation has to be multiplied. Moreover E1 comprehends 15 series of four registers, each of 8 bits, to be employed for storing and erasing the dynamic codes.

Each deconding module IIb of the receivers is composed analogously by a Microprocessor IC2 equal to IC1 and by an EEPROM E2 equal to E1.

Pins 6,4,5,16,15,3,2,1,19 of IC2 are connected as those of IC1 to the resonator, to the positive and negative supply, to reset, to E2, while the outputs corresponding to pins 7,8,9,10,11,12,13,14 are conneted through bus B2 to the controlled means in different way for each of said four means. In fact the output terminal U1,U2,U3 (pins 14,13,12) of MPD of the first car, corresponding to keys SW1,SW2,SW3 are connected respectively to the imput terminal of the central functioning module of the antitheft apparatus IAF of the first car, relating to the arming and disarming of IAF, to the control of the antirobbery function and to the control of the panic function of the same, and analogously the output terminal U4,U5.U6 (pins 11,10,9) of MPD of the second car corresponding to the keys SW4,Sw5,SW6 are connected respectively for the analogous functions to the central functioning module of IAF of the second car, while the output terminal U7,U8 (pins 8,7) corresponding to keys SW7,SW8 respectively of the MPD of the gate of the house and of that of the factory, are joined to the respective members of opening and closing of said gates.

Pin 20 is connected to input terminal TE1 of the messages coming from the receiving module.

The external components of IC2 corresponding to those of IC1 and which will be marked with the same referal numbers followed by an apostrophe, are R1′ (1 Mo), C1′ and C2′ (both 56 pF), C3′ (100 pF), R2′ (100 Ko) and D9′ (1N4148).

Upon assembling of the remote control device and of the radio receiver there are stored electrically in the three special registers of EEPROMC and of all EPROMD the base code constituted by 24 bits and that is by three words each of 8 bits, moreover in the special registers respectively the code of 4 bits of the succession of performance of the operations of the algortithm and that of the numerical coefficients of said operations.

Functioning of the devices.

When a key is acted, no matter which, the base of T2 is grounded through R7, so T2 is excited and brings the positive then through its emitter to the whole module Ia, and moreover the pin of IC1 connected to the switch corresponding to the acted key is brought low.

The program according to which IC1 is masked foresees the emitting, further to the negative to one of the pins connected to the switches SW, of a positive pulse from pin 18, which excites T1, which at its turn mantains in conduction through its collector, which goes to ground, T2 also after the ceasing of the acting of the key previously acted and that is of the reopening of the corresponding switch SW.

Upon its supplying IC1 reads the base code and the dynamic code, which at the beginning is nothing, and the instructions stored in E1 through the connection of its pin 3 to the pin 4 of E1, then calculates the new dynamic code and emits a series of messages encoded according to the base code and the new dynamic code and moreover according to the code of the channel and that is of the key, which has been acted and then of the input pin of the relating pulse.

Said messages received by the receivers II are transmitted by the receiving module IIa to the decoding module IIb, and arrive to pin 20 of IC2, which is constntly supplied and which as soon as it receives the message through its pin 3 connected to pin 4 of E2, reads in E2 the base code and the dynamic code stored, which in case of the first message is nothing, and moreover the instructions for the algorithm, which it has to perform on the base code for the first message and only on the dynamic code memorized for all messages received after the first one, then compare the base code and the new dynamic code to those of the input message and if corresponding emits a control signal from the pin corresponding to the channel code.

When any key of the remote control device is acted the relating encoded messages transmitted are received compatibly to the distance by all four receivers, and all the relating decoding modules emit after a positive checking of the base code and of the dynamic code of the detected messages a control signal from the output terminal corresponding to the acted key or from the output terminals corresponding to the keys, which has been acted contemporaneously, but there are controlled evidently only the central functioning modules of the means, which are connected to said output terminal.

So for example if the key SW3 is acted the relating emitted encoded message will be received by all four receivers and from the output terminal U3 of every one of the relating MPD will be output a control signal, which will act only the panic function of the first car because only the input terminal of the functioning module of the antitheft apparatus of the first car relating to said function is connected to the output terminal U3 of the relating MPD, while to the output terminal of the other three MPD no means is connected.

In case if the remote control device has been acted carelessly or not, very far from the car and then the relating emitted message has not been received by the radio receiver or the remote control device has been changed with a spare one or in any case with another device, the base code of which is the same of that of the original device, a transmitted message will be not able to be found corresponding by IC2 of the module IIb as far as it concerns the dynamic code; in these cases the program of IC2 foresees that if the comparison of the base code is positive, IC2 erases the dynamic code stored in E2 and stores in E2 the dynamic code of the received message, without naturally controlling the central functioning module.

It follows that the operator, having had no result the previous acting of the remote control device, will act newly the remote control device and the new encoded message transmitted will have a dynamic code resulted by the operation made on the dynamic code of the previous message and stored either by E1 and as above illustrated by E2 and therefore said following message will be found by IC2 in the comparison, which it will perform, valid and then IC2 will emit a control signal from the pin corresponding to the acted key of the remote control device.

Therefore also if a thief intercepts and stores a remote transmitted control message, it will be able to control no one of the means because the decoding modules are suitable to recognize the following messages only if their dynamic code is obtained fron the previous one on the ground of the algorithm, which can not be obtained by the thief not even with the interception of more messages. In fact the algorithm can be also very complicated and therefore it is absolutely impossible to pick it out.

The EEPROMs have been defined according to the duration of the registers, which are averagely able to endure 10.000 registrations and relating erasures, then with those choosen in the example one can act the remote control device for several tens of years.

Claims

1. Devices for the remote transmission of controls in security constituted by a remote control device comprising at least an encoder module, a transmitting module of the encoded messages, a source of power and a control key, and by a receiver connected to the means to control, comprising at least a module for receiving the encoded messages and a module of decoding, suitable to emit a control signal of said device after having checked the code of the received message, characterized in that:

- the encoding module of the remote control device comprises a microprocessor (MPC) and at least a EPROM (EPROC), being the microprocessor MPC such and equipped with such a program to be suitable to perform the following functions:
- when the remote control device is acted the first time:

- reading in the special register of the EPROMC and storing in its internal memory (RAM) the base code, expressed with a binary number and stored upon assembling of the remote control device,
- reading in the special registers of the EPROMC and storing in its RAM the instructions expressed with binary numbers, stored in said registers upon assembling of the remote control device, relating to the succession of performing and to the coefficients of the operations foreseen by the program of MPC, which form the algorithm, that the MPC has to perform on the binary number of the base code for reaching the dynamic code,
- performing said algorithm on the base code and finding then the new dynamic code,
- erasing the base code in the EPROMC and storing in its place the new dynamic code,
- transmitting to the transmissiom module the message encoded according to the new dynamic code, so that said module provides for the transmission,
- for all times the remote control device is acted after the fist time:
- performing the same functions foreseen for the first time operating not more on the base code but on the last dynamic code memorized in the EPROMC,
- and that the decoding module of the device joined to the means to control is constituted at least by a microprocessor (MPD) and a EPROM (EPROMD), being the MPD such and programmed in such a way to be suitable to perform the following functions when receives an input encoded message:
- for the first input message
- holding it in its internal memory (RAM),
- reading in the EPROMD the base code, the same as the base code of the encoding module of the remote control device and holding it in its RAM, being the base code, stored in the EPROMD, upon assembling, the same as that of the EPROMC,
- reading in the EPROMD and storing in its RAM the instructions relating to the algorithm, the same as those of the encoder, which the MPD has to perform on the base code already stored in its RAM, having been stored said instructions in the EPROMD upon assembling of the relating module,
- performing said algorithm and determining so the new dynamic code and storing it in its RAM,
- comparing the code of the imput message with the dynamic code by itself determined with the performance of the algorithm on the base code,
- and in case of correspondence:
- emitting control signal to said means,
- and in case of non-correspondence:
- emitting no control signal,
- for all messages received after the first one:
- performing all operations foreseen for the first message, operating not more on the base code but on the last dynamic code stored in the EPROMD.

2. Devices as fron claim 1. characterizzed in that the remote control device transmits messages encoded not only on the ground of the base code but on the ground of the base code and the dynamic code taken together, and therefore the MPC is equipped with such a program to be suitable to perform the same functions foreseen in the first solution only that the base code stored in the EPROMC is never erased and upon every acting of the remote control device the MPC reads in the EPROMC and stores in its RAM either the base code and the last stored dynamic code performs then the algorithm the first time on the base code and the following times only on the dynamic code and encodes the trasmitted messages on the ground of the double code constituted by the base code and the new dynamic code;
and the MPD is equipped of such a program to be suitable to perform the following functions:
- storing in its RAM the input encoded message,
- performing the algorithm on the dynamic code read in the EPROMD and determining so the new dynamic code,
- comparing the double code of the input message with the base code plus the the calculated dynamic code,
- in case of correspondence of both the two codes:
- emitting a control signal of said means,
- in case of correspondence of no one of the two codes:
- emitting no control signal,
- in case of correspondence of the base code but not of the dynamic code:
- to emit no control signal,
- and erasing the dynamic code stored in the EPROMD and storing in its place the dynamic code of the input message, in such a way that the following encoded message emitted by the remote control device will have a dynamic code calculated on the ground of of that stored in its EPROMC and that is equal to that of the previous transmitted message, received and stored in the EPROMD of MPD, that then in the comparison performed by the MPD will result equal to that stored in the EPROMD.

3. Devices as from claims 1. and 2. characterized in that the MPD is equipped with such a program to be suitable to perform before storing the new dynamic codes in the EPROMD the following functions:
- checking if the last register employed for storing the previous dynamic code is already working,
- in positive case storing the new dynamic code,
- and in negative case checking if a new register works,
- then in positive case storing in this register the new dynamic code,

- and in negative case checking a new register and repeating the function until a working register is found, and then storing in this the new dynamic code.

4. Devices as any one of the previous claims characterized in that the remote control device comprises two or more control keys and is suitable to control two or more means and/or one or more functions of one or more of said means, corresponding to acting of a different key the control of a different means and/or of a different function, being the MPC of the remote control device equipped with such a program to be suitable to encode every output message either on the ground of the base code and of the dynamic code, and on the ground of the code of the channel corresponding to the key or to the keys acted contemporaneously, being every means equipped with a receiver comprehending a MPD programmed in such a way to be suitable to perform all the functions foreseen in the previous solutions and to emit the control signals from the ouput terminal or terminals corresponding to the channel code of the input suitable to control the means and the functions of said means according to the pre-arrangment of the connections of said ones to the output pins of the relating MPD.

5. Devices as from claim 4. characterized in that the remote control device comprises a member suitable to act two or more keys contemporaneously.

FIG.1

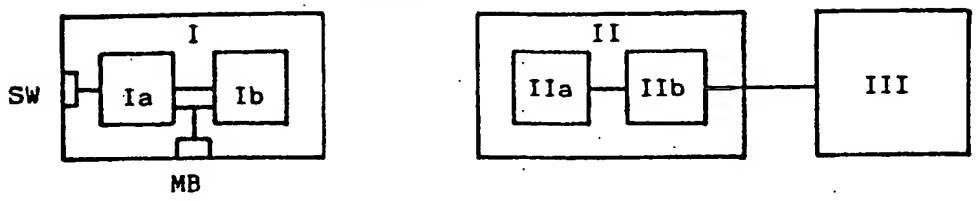


FIG.2

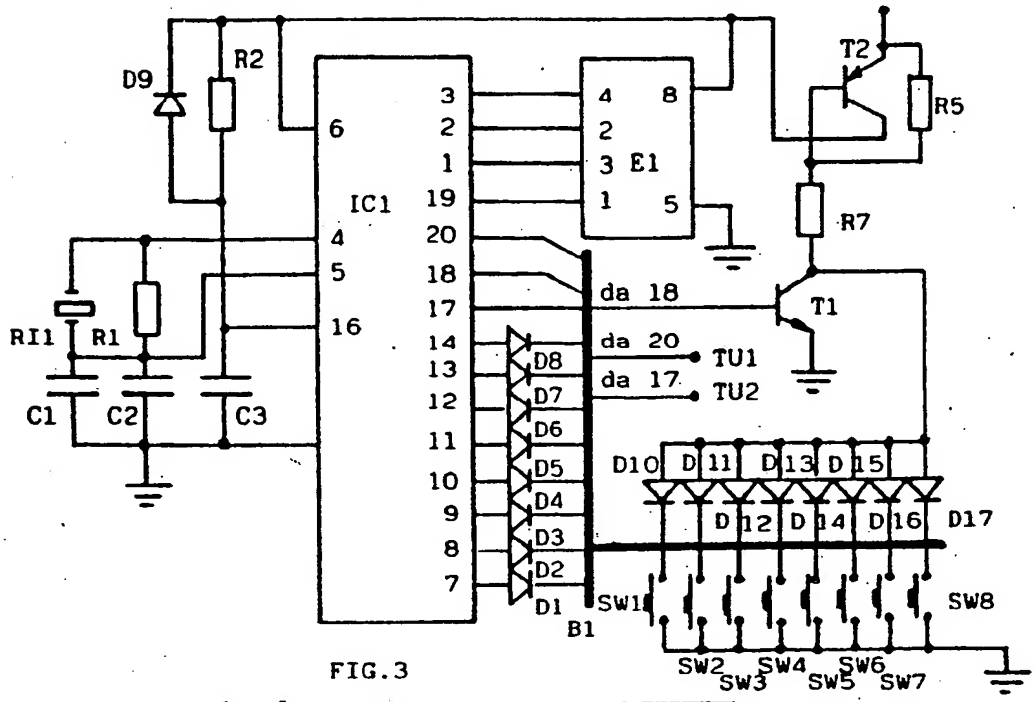
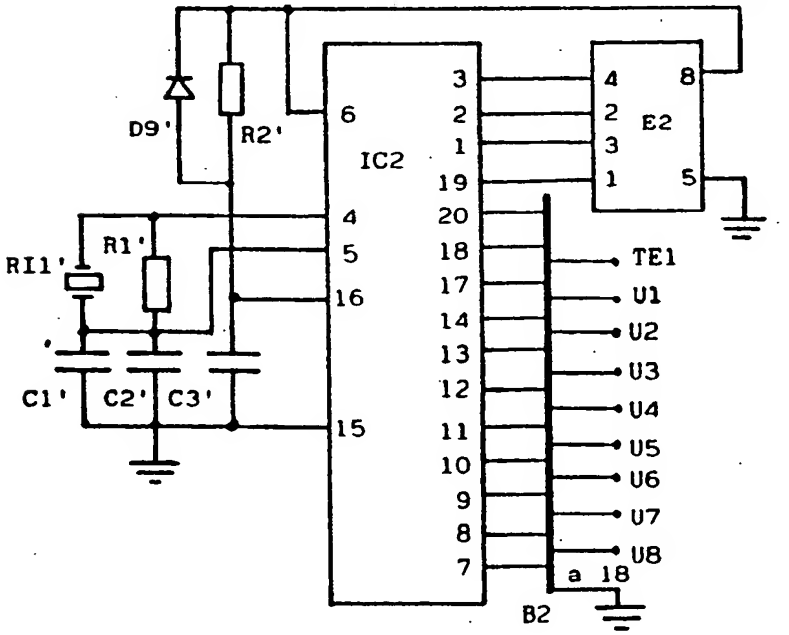


FIG.3



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EUROPEAN SEARCH REPORT

Application Number

EP 89 12 1425

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0151874 (DE LA RUE) * page 5, line 7 - page 9, line 15; figures *	1-5	G07C9/00 E05B49/00 B60R25/10
Y	EP-A-0068805 (VISA) * page 6, line 11 - page 10, line 4; figures *	1-4	G07F7/10
A		5	
Y	GB-A-2051442 (HOWARD) * page 1, line 19 - page 2, line 65; figures *	1-4	
A	WO-A-8707743 (BULL) * page 3, line 29 - page 9, line 14; figure 1 *	1-4	
A	IBM TECHNICAL DISCLOSURE BULLETIN. vol. 27, no. 3, August 1984, NEW YORK US pages 1758 - 1759; MARTIN: "Message replay prevention using a previously transmitted random number to sequence the messages" * the whole document *	1-4	
A	US-A-4207555 (TROMBLY) * column 1, line 61 - column 5, line 58; figures 1, 2 *	1-4	TECHNICAL FIELDS SEARCHED (Int. Cl.5) G07C G07F E05B B60R
A	DE-A-3211568 (SIEMENS) * page 10, line 5 - page 15, line 20; figure 1 *	1-5	
A	DE-A-3514660 (SIEMENS) * page 9, line 8 - page 11, line 18; figure 2 *	1-4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 MARCH 1990	MEYL D.

CATEGORY OF CITED DOCUMENTS

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FIG.1

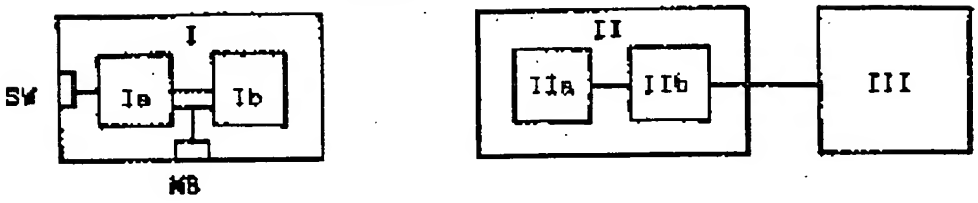


FIG.2

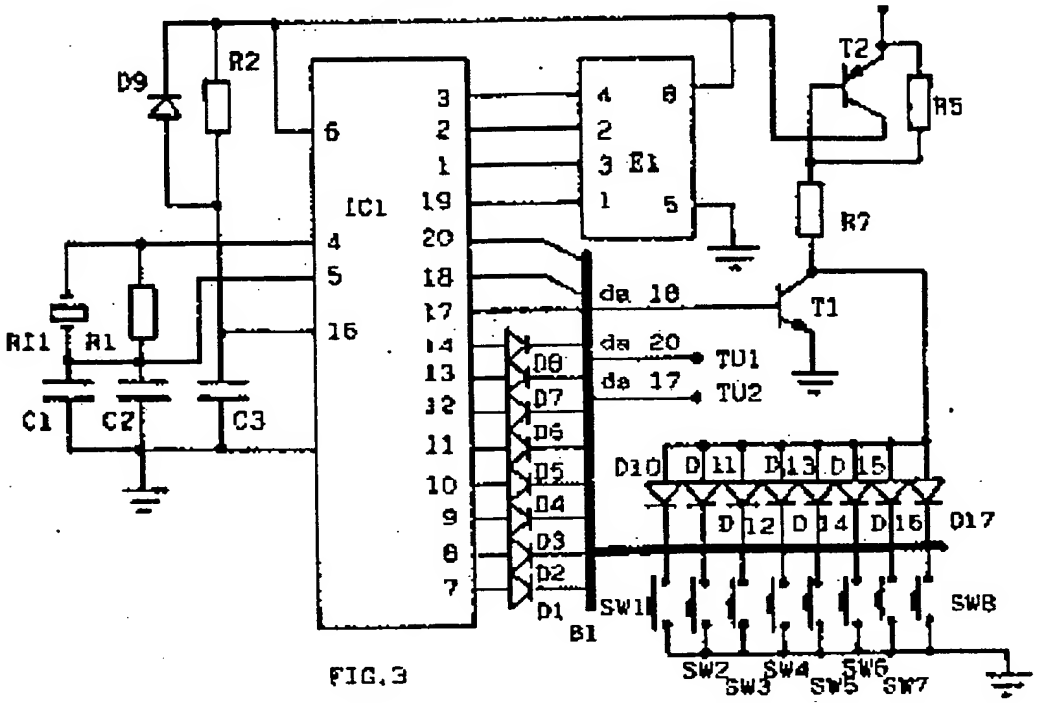
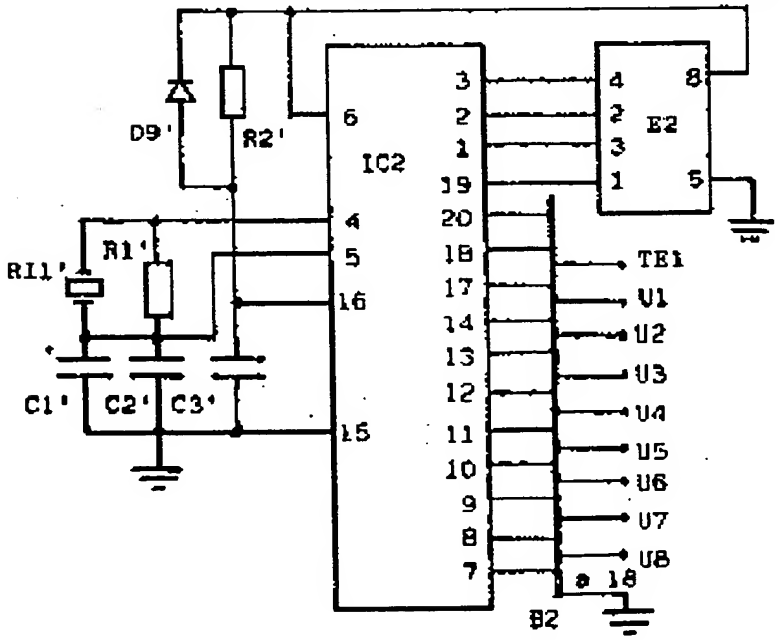


FIG.3



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